UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: Yuriy Gmirya

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Group Art Unit: 3655

Examiner: Le, David D.

Title: Split-Torque Gear Box

Commissioner for Patents
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P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Subsequent to the Notice of Appeal Filed 26 July, 2010, Appellant submits this Appeal Brief.

I. REAL PARTY IN INTEREST

The real party in interest is Sikorsky Aircraft Corporation, assignee of the present application. (Recorded at reel/frame: 014314/0358).

II. RELATED APPEALS AND INTERFERENCES

This application was previously appealed (appeal no. 2009-002750)—decided 13 November 2009. Appellant is unaware of any other related appeals/interferences.

III. STATUS OF THE CLAIMS

Claims 2, 20 and 25-27 stand cancelled.

Claims 28-37 stand withdrawn.

Claims 1, 3-19, 21-24, and 38-45 are pending, rejected, and herein appealed.

IV. STATUS OF AMENDMENTS

All amendments have been entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present application relates to a split torque gearbox. Specifically, this disclosure relates to a multiple path, three stages power gear train module that transmits torque from a high-speed engine to a low speed output shaft, providing equal gear load distribution due to floating pinion in the second stage of reduction. See, for example, Figs. 2-3 below.

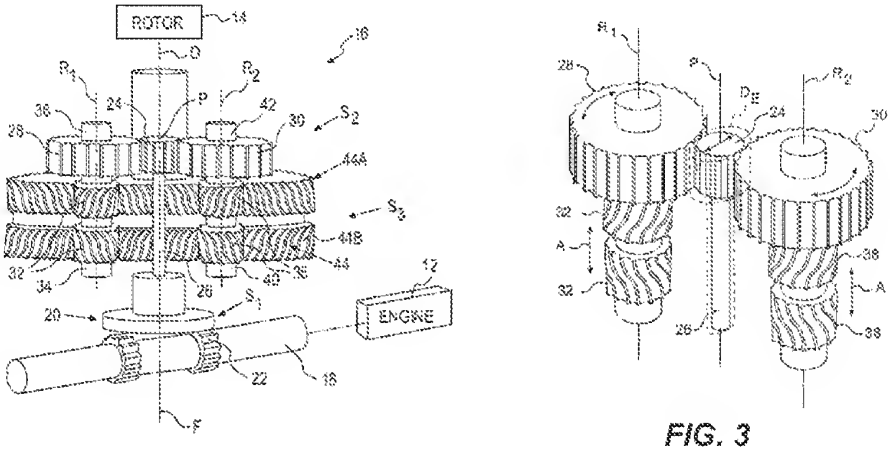


FIG. 3

A. Summary of Independent Claim 1

With reference to Figs. 2-3, claim 1 is directed to a split torque gearbox system 10. The system includes a first spur gear 28, a second spur gear 30, a floating pinion gear 24 mounted to a radially unsupported pinion shaft 26 in a cantilever manner and driven by the radially unsupported pinion shaft 26, the floating pinion gear 24 mounted for rotation about a floating pinion axis of rotation P which provides a resilient characteristic. [Page 4, lines 25-30.] The floating pinion gear 24 axis of rotation P displaceable to split a load between the first spur gear 28 and the second spur gear 30, the floating pinion axis of rotation P, the first spur gear 28 axis of rotation R1, and the second spur gear 30 axis of rotation R2 located along a common line L (e.g., see Figure 4). [Page 5, lines 1-5.] The radially unsupported pinion shaft 26 is driven through a gear mesh generally transverse to the floating pinion axis of rotation P such that the radially unsupported pinion shaft 26 is displaceable off the common line L (e.g., see Figure 4) to define a displacement envelope within which said floating pinion gear axis of rotation may be

displaced through flexing of said radially unsupported pinion shaft to split the load between the first spur gear 28 and the second spur gear 30.

B. Summary of Independent Claim 8

Referring in particular to Figs. 2-3, claim 8 is directed to a split torque gearbox system 10 for a rotary wing aircraft. A face gear 20 is driven by an input shaft 18 about a face gear 20 axis of rotation F. A floating pinion gear 24 is mounted to a radially unsupported pinion shaft 26 in a cantilever manner and is driven by the radially unsupported pinion shaft 26 mounted to the face gear 20, the floating pinion gear 24 mounted for rotation about a floating pinion axis of rotation P which provides a resilient characteristic. The floating pinion axis of rotation P, the first spur gear 28 axis of rotation R1, and the second spur gear 30 axis of rotation R2 located along a common line L (e.g., see Figure 4). [Page 5, lines 1-5.] The floating pinion axis of rotation P displaceable off the common line L (e.g., see Figure 4) define a displacement envelope within which said floating pinion gear axis of rotation may be displaced through flexing of said radially unsupported pinion shaft to split a load between the first spur gear 28 and the second spur gear 30. [Page 5, lines 5-9.] A first double helical gear 32 driven by the first spur gear 28, the first double helical gear 32 defined along the first spur gear 28 axis of rotation R1. [Page 5, lines 10-15.] A second double helical gear 38 driven by the second spur gear 30, the second double helical gear 38 defined along the second spur gear 30 axis of rotation R2 and an output gear 44 meshed with the first and second double helical gears 32, 38. [Page 5, lines 14-26.]

C. Summary of Independent Claim 12

Again, with reference to Figs. 2-3, claim 12 is directed to a method of splitting torque within a split torque gearbox system 10 includes: mounting a floating pinion gear 24 to a radially unsupported pinion shaft 26 in a cantilever manner, and driving the floating pinion gear 24 about the pinion gear axis of rotation P through a radially unsupported pinion shaft 26 which provides a resilient characteristic, the radially unsupported pinion shaft 26 driven through a gear mesh generally transverse to the pinion gear axis P [Page 4, lines 25-30]; and engaging the floating pinion gear 24 with a first gear 28 and a second gear 30, the first gear 28 rotating around a first gear axis of rotation R1, the second gear 30 rotating around a second gear axis of rotation R2, the first gear axis of rotation R1, the second gear axis of rotation R2 and the pinion gear axis

of rotation P located along a common line L (see Figure 4), the pinion gear axis of rotation P displaceable off the common line L (see Figure 4) to define a displacement envelope within which the floating pinion gear axis of rotation may be displaced through flexing of the radially unsupported pinion shaft to split a load between the first gear 28 and the second gear 30. [Page 5, lines 1-9.]

VII. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Appellant seeks review of the following grounds of rejection present in the Final Office action (mailed 3/22/2010):

A. Claims 1, 3, 4, 12, 16-19, 21-24, 38 and 41-44 are rejected under 35 U.S.C. § 102(b) as being anticipated by *White* (U.S. Patent No. 4,489,625).

B. Claims 5-11, 13-15, 39-40 and 45 are rejected under § 103(a) as being obvious over *White* in view of *Kish* (U.S. Patent No. 5,813,292).

VIII. ARGUMENTS

A. The § 102(b) rejection of the claims as being anticipated by *White*

Independent claims 1 and 12

Appellant wishes to argue claims 1, 3, 4, 12, 16-19, 21-24, 38 and 41-44 as a group. Independent claim 1 is representative, for purposes of this argument, of independent method claim 12, and thus claim 1 will be the focus of this argument.

1. *White does not expressly or inherently disclose a radially unsupported pinion shaft.*

As generally explained above, claim 1 requires:

> 1. A split torque gearbox system comprising:
> **a first spur gear** mounted for rotation about a first spur gear axis of rotation;
> **a second spur gear** mounted for rotation about a second spur gear axis of rotation; and
> **a floating pinion gear** mounted to **a radially unsupported pinion** shaft in a cantilever manner and driven by said radially unsupported pinion shaft… **said floating pinion gear meshed with said first spur gear and said second spur gear**… said floating pinion axis of rotation, said first spur gear axis of rotation, and said second spur gear axis of rotation located along a common line, **said radially unsupported pinion shaft driven through a gear mesh generally transverse to the floating pinion axis of rotation such that said radially unsupported pinion shaft is displaceable off said common line** to define a displacement envelope …

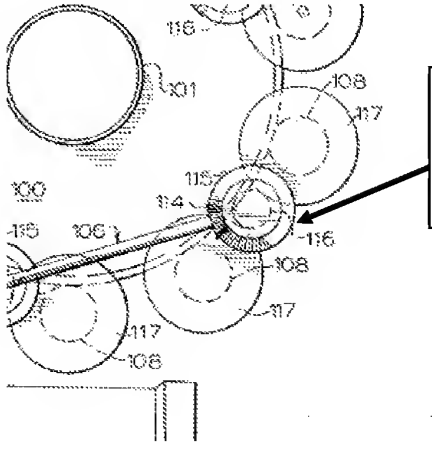
(emphasis added) In other words, a pinion is between the first spur gear and the second spur gear, the pinion and the fist and second spur gears are located along a common line, and a "radially unsupported pinion shaft" (e.g., Appellant's element 26) is associated with the pinion.

The Examiner interprets *White* as follows:

- A first spur gear (i.e., Fig. 7, element 117, and column 5, lines 15-18) mounted for rotation about a first spur gear axis of rotation (see Fig. 8);
- A second spur gear (i.e., Fig. 7, element 117, and column 5, lines 15-18) mounted for rotation about a second spur gear axis of rotation (see Fig. 8);
- A floating pinion gear (i.e., Fig. 7, element 116) driven by a radially unsupported pinion shaft mounted to the face gear, the floating pinion gear meshed with the first spur gear and the second spur gear, and the floating pinion gear mounted for rotation about a floating pinion axis of rotation which provides a resilient characteristic (i.e., Fig. 7; column 11, lines 26-43);

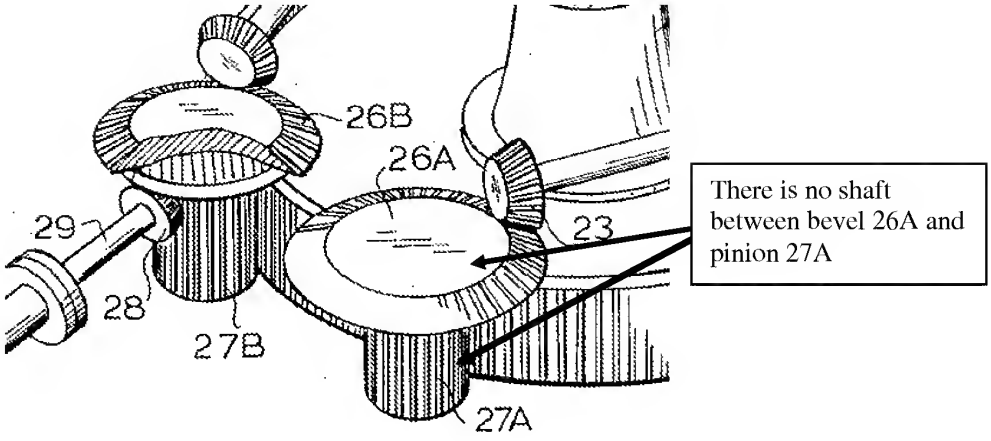
Examiner does not identify a "pinion shaft" in *White*

(See Final at 3-4). Notably, the Examiner has not specifically identified a "radially unsupported pinion shaft" in *White*. This is because *White* is silent as to whether it uses such a pinion shaft. Further of note, only element 116 in White can possibly be identified as the claimed pinion because of the requirement that the pinion and the first and second spurs gears are disposed on a common line. See, for example the relevant portion of *White*, Fig. 7, below.



Examiner identifies element 116 as the claimed pinion gear, however there is no evidence of a pinion shaft.

As argued previously, there is simply no side view of elements 115-116 in Figure 7 of *White*. (Request for Reconsideration at page 4). *White* also does not disclose in its text that any kind of shaft is associated with element 116. In fact, *White* actually teaches pinions 27A-B in Figure 3, below, which do not include shafts between bevels 26A-B. Elements 115-116 likely follow elements 26-27 in this regard.



Accordingly, *White* is at best ambiguous as to whether the pinion 116 is associated with a "radially unsupported pinion shaft," as required by the claims, and *White* actually appears to teach away from using a shaft. Thus, *White* does not **expressly** disclose the claimed "radially unsupported pinion shaft." Further, *White* does not need a shaft between elements 115 and 116, as is demonstrated by the embodiment of Figure 3. Thus, *White* does not **inherently** disclose a pinion shaft associated with the pinion 116. Since *White* neither expressly nor inherently discloses the claimed "radially unsupported pinion shaft," there is no anticipation, and the Examiner's rejection should be reversed.

On a similar argument, the Board previously found this:

> Since White describes that the driving position of the floating pinion gear **116** is set by the balance of the two diametrically opposed mesh forces of driven gears **117** (Fact 6), we find that the floating pinion gear is able to adapt to the position that it floats to and, therefore, has a resilient characteristic. Therefore, we see no error in the Examiner's finding that White's radially unsupported pinion has a resilient characteristic (Fact 4).
>
> Accordingly, we find that White describes a radially unsupported pinion shaft and a floating pinion gear mounted for rotation about a floating pinion axis of rotation, which provides a resilient characteristic as called for in claim 1.

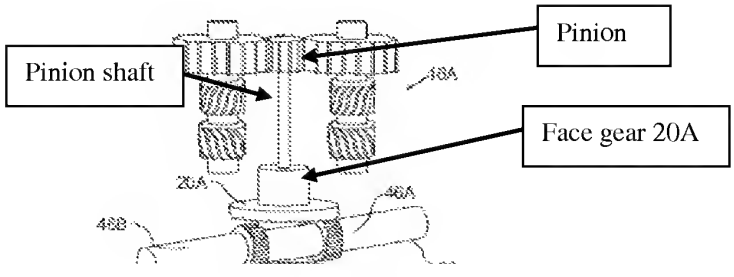
(13 November 2009 Decision on Appeal at page 12). With respect, simply because a pinion may have a resilient characteristic, it does not follow that a pinion **shaft** is disclosed. As explained above, there is no evidence of any such pinion shaft in *White*, and thus there is no anticipation.

Dependent claim 3

Dependent claim 3 depends from claim 1 and is argued separately, notwithstanding the above arguments. Claim 3 recites:

> 3. The split torque gearbox system as recited in claim 1, further comprising a **face gear mounted to said pinion shaft** to define said gear mesh generally transverse to the floating pinion axis of rotation.

(emphasis added). As explained above, *White* does not disclose a pinion shaft, and therefore *White* cannot disclose a face gear mounted to the pinion shaft. For Example, see the relevant portion of Appellant's Figure 5, below.



The Examiner has identified element 115 in *White* as a face gear, however there is no evidence that a shaft extends between *White's* elements 115 and 116. In fact, element 116 could be

connected to element 115 without a shaft, as is generally shown in Figure 3 of *White*. If one were to somehow interpret claim 1's pinion shaft as element 115 in *White* (which is not a shaft), **then claim 3 overcomes that interpretation**. White simply does not disclose the combination present in claim 3, and thus the rejection should be reversed for this separate reason.

Dependent claim 24

Dependent claim 24 depends from independent claim 1. Notwithstanding the above argument, Appellant wishes to argue this claim separately.

Claim 24 recites:

> 24. The split torque gearbox system as recited in claim 1, wherein said displacement envelope **is generally diamond shape**.

(emphasis added). That is, the radially unsupported pinion shaft is displaceable to define a displacement envelope, and the displacement envelope is diamond shaped. For example, see Appellant's diamond shaped displacement envelope disclosed in Figures 3-4, below.

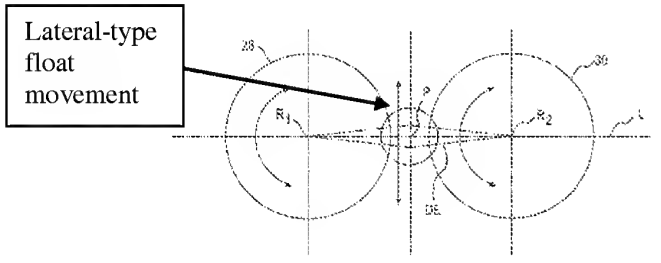


FIG. 4

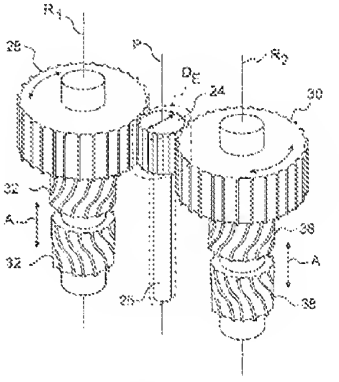


FIG. 3

Because Appellant's pinion shaft 26 is radially unsupported, a diamond shaped displacement envelope DE can be realized.

Since the pinion 116 in *White* is not associated with a pinion shaft (as explained above), *White* cannot define a displacement envelope of a particular defined shape, let alone a displacement envelope that is diamond shaped. For one, while the Board found that *White's* pinion floats, there is simply no evidence that it would define a diamond shaped displacement envelope. *White's* pinion could float axially (e.g., up and down), and thus it would not exhibit

the lateral movement similar to that shown in Figure 4, and its displacement envelope would not be diamond-shaped.

Accordingly, *White* does not anticipate claim 24, and thus the rejection should be reversed.

B. The § 103 rejection of the claims as being obvious over *White* in view of *Kish*

Independent claim 8

Independent claim 8 includes the above-argued feature of a "radially unsupported pinion shaft." Thus, should the Board reverse the Examiner's § 102 rejection of claim 1 on the above-argued grounds, for example, then the Board should similarly reverse this § 103 rejection of claim 8 as lacking a prima facie case of obviousness. But further, claim 8, among others, is argued below.

1. *White has no need for a double helical gear.*

Claims 5-11, 13-15, 39-40 and 45 are patentable for the following separate reason. Claim 8 is representative of this group of claims, and thus the below argument will focus on claim 8, the relevant portion of which is copied below.

Claim 8 requires:

> 8. A split torque gearbox system for a rotary wing aircraft comprising:
> an input shaft;
> a face gear driven by said input shaft about a face gear axis of rotation;
> a first spur gear …;
> a second spur gear …; and
> a floating pinion gear mounted to a radially unsupported pinion shaft …
> **a first double helical gear driven by said first spur gear**, said first double helical gear defined along said first spur gear axis of rotation;
> **a second double helical gear driven by said second spur gear**, said second double helical gear defined along said second spur gear axis of rotation; and
> an output gear meshed with said first and second double helical gears.

(emphasis added). For example, see Appellant's double helical gears 32, 38, in Figures 2-3, below.

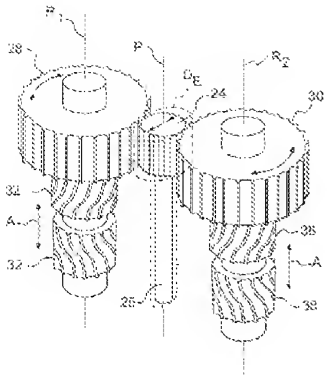


FIG. 3

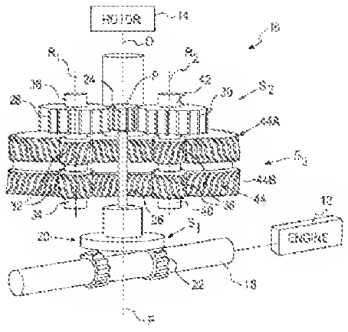


FIG. 2

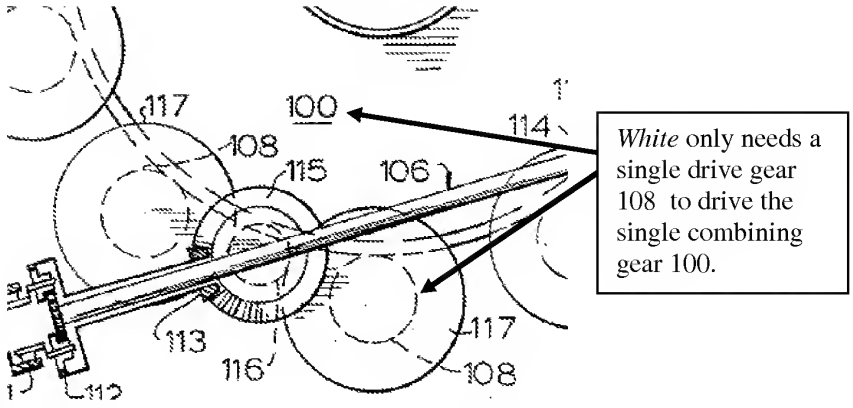
Notably, Appellant employs double helical gears because there are two separate meshes 44A and 44B that need to be driven. (See Figure 2, above).

The Examiner has essentially interpreted claim 8, using *White*, in the same manner that he has interpreted claim 1. (For example, see the Final at page 6). The Examiner admits that *White* lacks the following features:

- A first double helical gear driven by the first spur gear;
- A second double helical gear driven by the second spur gear; and
- Wherein the first double helical gear is of a smaller diameter than the first spur gear and the second double helical gear is of a smaller diameter than the second spur gear.

(Final at page 6). The Examiner then concludes that *Kish* teaches these features, and that it would have been obvious to combine the two in order to "provide an effective torque splitting transmission." (Final at page 7).

While *Kish* does appear to disclose a plurality of double helical gears (e.g., see elements 118L and 118R in Figure 1 of *Kish*), *Kish's* disclosure, in this regard, is wholly irrelevant. Simply, there is no reason to modify *White* to include the claimed double helical gears. *White* employs single drive gears 108 because *White* only drives a single combining gear 100. See the relevant portion of Figure 7 of *White*, below.



Modifying *White's* single drive gears 108 into double helical gears, as the Examiner attempts to do, would be superfluous at best. Since *White* is only concerned with driving the single combining gear 100, there is no need for each of *White's* spur gears to be provided with a double helical gear. Since the Examiner's modification would serve no purpose, there is no reason to make the modification. This is hindsight in its purest form. Accordingly, the claims are non-obvious and the rejection should be reversed.

IX. CONCLUSION

For the foregoing reasons, the rejections in the final rejection should be reversed.

Respectfully Submitted,
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Dated: September 27, 2010

APPENDIX OF CLAIMS

1. A split torque gearbox system comprising:

a first spur gear mounted for rotation about a first spur gear axis of rotation;

a second spur gear mounted for rotation about a second spur gear axis of rotation; and

a floating pinion gear mounted to a radially unsupported pinion shaft in a cantilever manner and driven by said radially unsupported pinion shaft, said floating pinion gear mounted for rotation about a floating pinion axis of rotation which provides a resilient characteristic, said floating pinion gear meshed with said first spur gear and said second spur gear, said floating pinion gear axis of rotation displaceable to split a load between said first spur gear and said second spur gear, said floating pinion axis of rotation, said first spur gear axis of rotation, and said second spur gear axis of rotation located along a common line, said radially unsupported pinion shaft driven through a gear mesh generally transverse to the floating pinion axis of rotation such that said radially unsupported pinion shaft is displaceable off said common line to define a displacement envelope within which said floating pinion gear axis of rotation may be displaced through flexing of said radially unsupported pinion shaft to split said load between said first spur gear and said second spur gear.

3. The split torque gearbox system as recited in claim 1, further comprising a face gear mounted to said pinion shaft to define said gear mesh generally transverse to the floating pinion axis of rotation.

4. The split torque gearbox system as recited in claim 3, wherein said gear mesh includes a spiral bevel gear teeth arrangement

5. The split torque gearbox system as recited in claim 1, further comprising:

a first double helical gear driven by said first spur gear, said first double helical gear defined along said first spur gear axis of rotation; and

a second double helical gear driven by said second spur gear, said second double helical gear defined along said second spur gear axis of rotation.

6. The split torque gearbox system as recited in claim 5, further comprising an output gear meshed with said first and second double helical gear.

7. The split torque gearbox system as recited in claim 6, further comprising a main rotor shaft driven by said output gear.

8. A split torque gearbox system for a rotary wing aircraft comprising:

an input shaft;

a face gear driven by said input shaft about a face gear axis of rotation;

a first spur gear mounted for rotation about a first spur gear axis of rotation;

a second spur gear mounted for rotation about a second spur gear axis of rotation; and

a floating pinion gear mounted to a radially unsupported pinion shaft in a cantilever manner and driven by said radially unsupported pinion shaft mounted to said face gear, said floating pinion gear mounted for rotation about a floating pinion axis of rotation which provides a resilient characteristic said floating pinion gear meshed with said first spur gear and said second spur gear, said floating pinion axis of rotation, said first spur gear axis of rotation, and said second spur gear axis of rotation located along a common line, said floating pinion axis of rotation displaceable off said common line to define a displacement envelope within which said floating pinion gear axis of rotation may be displaced through flexing of said radially unsupported pinion shaft to split a load between said first spur gear and said second spur gear;

a first double helical gear driven by said first spur gear, said first double helical gear defined along said first spur gear axis of rotation;

a second double helical gear driven by said second spur gear, said second double helical gear defined along said second spur gear axis of rotation; and

an output gear meshed with said first and second double helical gears.

9. The split torque gearbox system as recited in claim 8, further comprising a main rotor shaft driven by said output gear.

10. The split torque gearbox system as recited in claim 8, wherein said input shaft is driven by a gas turbine engine.

11. The split torque gearbox system as recited in claim 8, wherein said face gear defines a gear face perpendicular to said face gear axis of rotation, said input shaft angled relative said gear face.

12. A method of splitting torque within a split torque gearbox system comprising the steps of:

(1) mounting a floating pinion gear to a radially unsupported pinion shaft in a cantilever manner and driving said floating pinion gear about a pinion gear axis of rotation through said radially unsupported pinion shaft which provides a resilient characteristic, the radially unsupported pinion shaft driven through a gear mesh generally transverse to the pinion gear axis; and

(2) engaging the floating pinion with a first gear and a second gear, the first gear rotating around a first gear axis of rotation, the second gear rotating around a second gear axis of rotation, the first gear axis of rotation, the second gear axis of rotation and the pinion gear axis of rotation located along a common line, the pinion gear axis of rotation displaceable off the common line to define a displacement envelope within which the floating pinion gear axis of rotation may be displaced through flexing of the radially unsupported pinion shaft to split a load between the first gear and the second gear.

13. A method as recited in claim 12, further comprising the steps of:

driving a first double helical gear by the first gear, the first double helical gear rotating about the first gear axis of rotation and axially movable along the first gear axis of rotation; and

driving a second double helical gear by the second gear, the second double helical gear rotating about the second gear axis of rotation, and axially movable along the second gear axis of rotation.

14. A method as recited in claim 13, further comprising the steps of:

driving an output gear about an output gear axis of rotation with the first and second double helical gear.

15. A method as recited in claim 13, further comprising the steps of:

driving a rotor system about the output gear axis of rotation with the output gear.

16. A method as recited in claim 12, further comprising the steps of:

driving a face gear which defines the gear mesh generally transverse to the pinion gear axis about a face gear axis of rotation with a high speed input shaft;

driving the floating pinion with the face gear through a floating pinion shaft.

17. A method as recited in claim 16, further comprising the steps of:

driving the high speed input shaft along an input shaft axis of rotation which is angled relative the face gear.

18. A method as recited in claim 17, further comprising the steps of:

driving a second face gear about a second face gear axis of rotation, the second face gear axis of rotation parallel to the face gear axis of rotation.

19. A method as recited in claim 17, further comprising the steps of:

driving a second face gear about a second face gear axis of rotation, the second face gear axis of rotation defined along the face gear axis of rotation.

21. The split torque gearbox system as recited in claim 1, wherein said floating pinion gear is mounted to a distal end of said radially unsupported pinion shaft.

22. The split torque gearbox system as recited in claim 1, wherein a displacement envelope within which said floating pinion gear axis of rotation may be displaced is non-linear.

23. The split torque gearbox system as recited in claim 1, wherein said displacement envelope is transverse to said floating pinion gear axis of rotation.

24. The split torque gearbox system as recited in claim 1, wherein said displacement envelope is generally diamond shape.

38. The split torque gearbox as recited in claim 1, wherein said floating pinion axis of rotation, said first spur gear axis of rotation, and said second spur gear axis of rotation are generally parallel.

39. The split torque gearbox system as recited in claim 9, wherein said floating pinion axis of rotation, said first spur gear axis of rotation, and said second spur gear axis of rotation are generally parallel to a main rotor axis of rotation defined by said main rotor shaft.

40. The split torque gearbox system as recited in claim 6, wherein said first double helical gear is of a smaller diameter than said first spur gear and second double helical gear is of a smaller diameter than said second spur gear.

41. The split torque gearbox system as recited in claim 1, further comprising:

a face gear driven about a face gear axis of rotation, said radially unsupported pinion shaft mounted to said face gear;

a first gear driven by said first spur gear, said first gear defined along said first spur gear axis of rotation;

a second gear driven by said second spur gear, said second gear defined along said second spur gear axis of rotation;

an output gear meshed with said first gear and second gear; and

a first spur gear periphery of said first spur gear and a second spur gear periphery of said second spur gear at least partially overlaps an output gear periphery of said output gear adjacent a first side of said output gear, and a face gear periphery of said face gear at least partially overlaps said output gear periphery adjacent a second side of said output gear.

42. The split torque gearbox system as recited in claim 41, further comprising:

an input shaft meshingly engaged with said face gear to define a gear mesh generally transverse to the floating pinion axis of rotation, said input shaft non-perpendicular to the floating pinion axis of rotation.

43. The split torque gearbox system as recited in claim 41,wherein said first gear includes a first double helical gear and said second gear includes a second double helical gear.

44. The split torque gearbox system as recited in claim 41, further comprising a main rotor shaft driven by said output gear.

45. The split torque gearbox system as recited in claim 8, wherein a first spur gear periphery of said first spur gear and a second spur gear periphery of said second spur gear at least partially overlaps an output gear periphery of said output gear adjacent a first side of said output gear, and a face gear periphery of said face gear at least partially overlaps said output gear periphery adjacent a second side of said output gear.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

This application was previously appealed (appeal no. 2009-002750)—decided 13 November 2009. Appellant is unaware of any other related appeals/interferences.